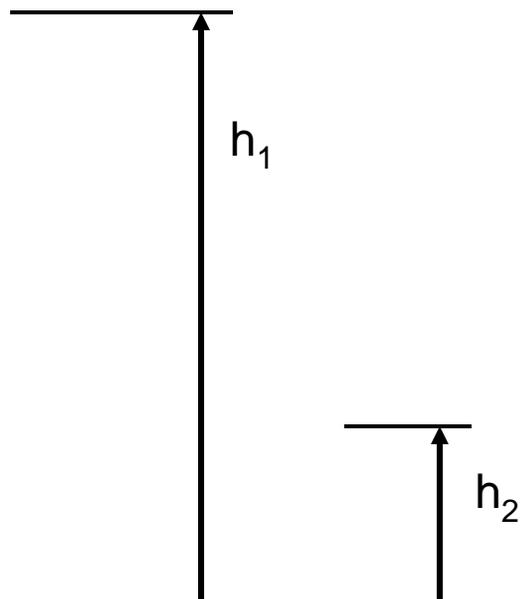# Lecture 1 - summary

- Introduction to the engineering science approach

- Galileo problem: Could we simply 'upscale' an animal, human.. several times and could it still exist?

- Dimensional analysis shows: If same material is used, a monster can not exist

- Remedy: Change material (density) as the height is increased in order to create physical similarity

Express physical situation as function of nondimensional parameters (critical: find correct dependence on variables)

$$mg \leq F_{\text{lim}} = f\left(h, g, \rho, V, \sigma_0\right)$$

Galileo's Problem:

$$\Pi_0 = \frac{F_{\text{lim}}}{h^2 \sigma_0} = \mathcal{F}\left(\Pi_1 = \frac{hg\rho}{\sigma_0}, \Pi_2 = \frac{V}{h^3}\right)$$

$$\rho g \Pi_2 h^3 \leq \Pi_0 \sigma_0 h^2$$

Robustness: $\quad \gamma = \dfrac{F_{\text{lim}}}{mg} = \dfrac{\Pi_0(\Pi_1, \Pi_2)}{\Pi_2 \Pi_1} \geq 1$

Thus, for a monster to exist need material with higher strength OR material with lower density.

Definition of **Galileo number**: $\boxed{\mathcal{N}_{Gal} = \dfrac{hg\rho}{\sigma_0}}$

Two events are similar if the invariants are the same, here the Galileo Number:

$$\Pi_1^{(1)} = \Pi_1^{(2)} = \frac{h^{(i)} \rho^{(i)} g}{\sigma_0^{(i)}} \qquad \boxed{\lambda = \frac{h_1}{h_2} = \frac{\sigma_0^{(1)}}{\sigma_0^{(2)}} \frac{\rho^{(2)}}{\rho^{(1)}}}$$

h_1

h_2